Evaluation of Potential Aseismic Creep Along the Ouachita Frontal Fault Zone, Southeastern Oklahoma

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INVESTIGATIONS UNDERTAKEN

This investigation is designed to evaluate previously reported field evidence of historic aseismic creep along the 50-km-long western part of the Ouachita Frontal fault zone (OFFZ) in southeastern Oklahoma. By evaluating existing evidence of possible aseismic creep along this fault, we are testing the hypothesis that the OFFZ may be a previously unrecognized seismic source in the central US. If evidence of active creep along the OFFZ is attributable to tectonic processes, we suggest that the fault zone be considered as a possible source of earthquakes. In short, we are asking the question: is the western part of the OFFZ an active tectonic feature?

We are evaluating the possibility of aseismic creep along the Choctaw fault, a component of the western OFFZ that trends northeast across Atoka County, Oklahoma. This fault is the westernmost of a series of thrust faults within the Paleozoic southern Ouachita fold and thrust belt. The orientation and location of the Choctaw fault are favorable to re-activation in the present-day stress field observed in the mid-continent. The fault is not associated with historical seismicity. Based on our initial field reconnaissance, we cannot rule out the possibility of aseismic tectonic creep on the fault, as suggested by previous research. In the town of Atoka, the fault traverses a small, linear hill upon which there is an alignment of historic damage to cultural features (e.g., sidewalks, curbs, pipelines, rock walls) from left-lateral ground movement. On the basis of about 140 mm of left-lateral offset of a sidewalk (dated October 27, 1914), we estimate a rate of left-lateral offset of about 1 to 2 mm/yr. In a qualitative sense, this rate seems reasonable given the degree of deformation we observed in houses and other cultural features along this alignment in Atoka. Previous workers concluded that the damage is not related to downslope movement, freeze-thaw processes or dissolution collapse, and instead is due to faulting in the absence of earthquakes. Our preliminary field observations are consistent with this conclusion, and therefore we continue to consider that the observed historic deformation may be related to aseismic creep. However, we also consider the null hypothesis that the deformation may be related to non-tectonic processes.

Our investigative approach involves documentation of the characteristics of the deformation and comparison with criteria previously developed to differentiate between features produced by tectonic and non-tectonic processes (NUREG/CR-5503). Our initial analysis of aerial photography along the OFFZ shows the presence of multiple prominent lineaments along mapped fault traces, although these may be related to lithologic control of slope and vegetation. Currently we are mapping these lineaments to identify other locations of possible historical or older deformation. After detailed delineation of the deformation of cultural and geologic features, we will interpret the spatial distribution of damage relative to possible locations of hillslope instability or other non-tectonic processes. We will document the amounts of offset of cultural features having various ages, in order to identify possible episodes of movement, and compare the temporal pattern of slip with episodes of nearby hydrocarbon and groundwater extraction. When a suitable target is identified,

we will conduct limited subsurface exploration across the apparent fault trace or other potentially fault-related features in order to assess whether or not the features are related to tectonic creep or non-tectonic processes.

If the features are found to be tectonic, this effort will provide an initial characterization of a potentially active seismic source in the mid-continent. The products of this research will be the documentation of features that address the presence or absence of active creep along the fault zone, and an assessment of whether the OFFZ is a potentially active seismic source. If evidence of active creep along the fault zone is attributable to tectonic processes, the OFFZ may be a previously unrecognized seismic source in the central US. If so, revisions to seismic-source characterizations and seismic hazard models in the mid-continent may be called for, in order to provide a more accurate assessment of potential seismic sources for local hazard analyses and regional seismic hazard maps.

NON-TECHNICAL SUMMARY

This study is investigating whether or not damage to houses, sidewalks, pipeline and other cultural features in Atoka, Oklahoma are related to recent fault movement. Damage to these features was identified in 1935, and confirmed recently by our observations. By characterizing the location and pattern of damage, we are determining if the fault is a previously unrecognized seismic source in the central US, and thus may be a potential source of future earthquakes for the mid-continent.

REPORTS PUBLISHED

None.

DATA AVAILABILITY

Additional detailed information on the investigation is available from the Principal Investigator listed above.